ความสัมพันธ์ระหว่างการขยายตัวการท่องเที่ยวกับการปล่อยก๊าซคาร์บอนไดออกไซด์ในประเทศไทย

Relationship between Tourism Expansion and CO2 Emissions in Thailand

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บทคัดย่อ

การวิจัยนี้มีวัตถุประสงค์เพื่อตรวจสอบความสัมพันธ์ระหว่างการขยายตัวการท่องเที่ยวและ การปล่อยก๊าซคาร์บอนไดออกไซด์จาก ภาคการขนส่ง การใช้พลังงาน และการใช้ไฟฟ้าในประเทศไทย โดยใช้การทดสอบความเป็นสาเหตุและผลตามวิธีของ Toda and Yamamoto (1995) ศึกษาข้อมูลตั้งแต่ปี 2523-2556 ผลการศึกษาพบว่า การขยายตัวการท่องเที่ยวและการปล่อยก๊าซคาร์บอนไดออกไซด์จากการใช้พลังงานมีความเป็นสาเหตุและผลซึ่งกันและกัน ขณะที่การปล่อยก๊าซคาร์บอนไดออกไซด์จากภาคการขนส่งและการใช้ไฟฟ้าเป็นสาเหตุต่อการขยายตัวการท่องเที่ยว ดังนั้นผู้กำหนดนโยบายควรมีมาตรการด้านนโยบายพลังงานปิโตรเลียมที่เหมาะสม เช่น การเก็บภาษีปิโตรเลียม การจ่ายเงินอุดหนุน อีกทั้งประเทศไทยควรออกแบบการรณรงค์การท่องเที่ยวสีเขียวสำหรับนักท่องเที่ยว เพื่อเป็นการลดปริมาณการปล่อยก๊าซคาร์บอนไดออกไซด์จากการใช้พลังงานและการปรับเปลี่ยนพฤติกรรมของนักท่องเที่ยว

คำสำคัญ: ประเทศไทย; การปล่อยก๊าซ CO2; การท่องเที่ยวกับสิ่งแวดล้อม; การท่องเที่ยว

Abstract

The aim of this research is to examine the relationship between tourism expansion and CO2 emissions from the transport sector, energy consumption and electricity consumption in Thailand. Using the Toda and Yamamoto (1995) causality test over the period 1980-2013, the results show bi-directional causality between tourism expansion and CO2 emissions from energy consumption; There is unidirectional running from CO2 emissions from the transport sector and electricity consumption to tourism expansion. This study suggests that policymakers should suitably provide a petroleum energy policy such as petroleum taxes and compensation. Additionally, Thailand should

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create green tourism campaigns for tourists to reduce CO2 emissions from energy consumption and to change tourist behaviors.

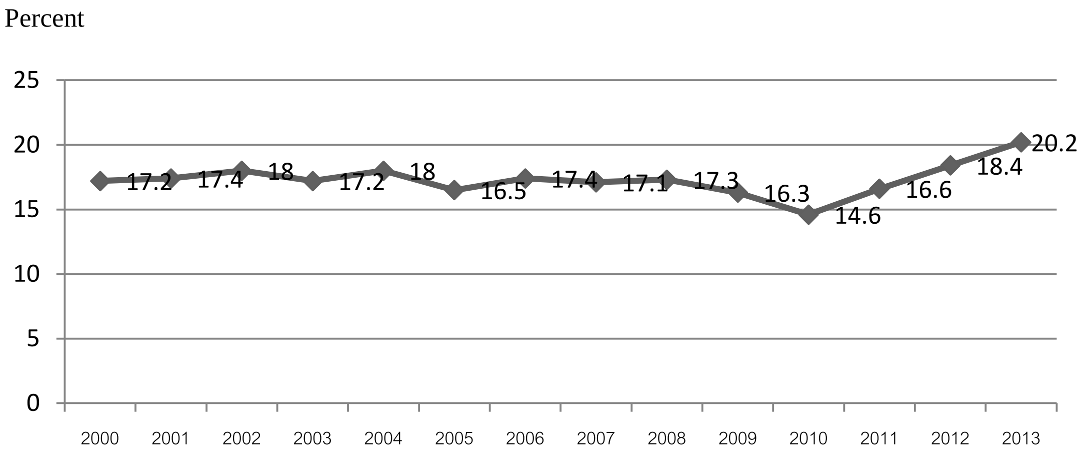
Keywords: Thailand; CO2 Emissions; Tourism and Environment; Tourism

Introduction

Thailand has been recently using the slogan "Amazing Thailand" in its promotion of tourism. The country is renowned worldwide for its southern beach resorts, with annual visitor numbers to the Andaman coast reaching over 7 million (The Mekong Tourism Coordinating Office, 2008). Other attractions include the capital, Bangkok, and the northern provinces, which are famous for their natural beauty and for the opportunity to visit ethnic villages in the mountain areas. Thailand's spicy cuisine is a further draw for foreign visitors, many of whom have been introduced to Thai food in restaurants in their home countries and who relish the chance to sample genuine Thai dishes in authentic surroundings. The plentiful tourism resources of Thailand as well as good environmental management can induce many international tourists to visit Thailand.

The tourism is one of key sectors of economic development. The World Travel and Tourism Council (2014) reported that Thailand's tourism contributed an average of more than 17 percent of gross domestic product (GDP) during the period in 2000 - 2013. In particular, tourism contributed 20.2 percent to Thailand's GDP in 2013. The trend of tourism contribution to GDP has been gradually increasing over a long period. From 2008 to 2013, Thailand experienced political instability such as Suvanabhumi International Airport being closed by the yellow shirt group in 2008 (Nonthapot and Lean, 2013) and the protest against the Thai government starting in November 2013 before the general election on 2nd February 2014 by many groups in Bangkok (BBC News, 2014). However, the tourism contribution to GDP recovered in 2011 and is still important for Thailand's economy (Figure 1).

Generally, tourism is considered as an "environmental friendly industry without chimneys" (Mirbabayev and Shagazatova, 2006). It means that the environment is a factor related to tourism. The study of the relationship between tourism and the environment by using time series analysis has not been widely discussed in empirical studies in ASEAN countries, especially the relationship between international tourism and the environment in terms of CO2 emissions.



Source: World Travel and Tourism Council (2014)

Figure 1 Tourism as a Percentage of Contribution to GDP 2000 – 2013

Beladi et al. (2009) investigated a small open economy concerning tax resulting from tourism using pollution taxes and found that taxes can reduce pollution emissions, but also increase tourism costs. In addition, the relationship between tourism and the environment has been considered in Thailand by Jatuporn and Chien (2011) in the causal relationship between tourism development and CO2 (carbon dioxide) emissions in Thailand over the period of 1986 to 2010. The result showed that the number of international tourist arrivals to Thailand would increase energy consumption and CO2 emissions.

Environmental indicators are ignored by the government and regulators especially in developing countries such as Thailand where environmental problems caused by tourists may not be recognized. This may be because the Thailand's government focuses on the contribution from tourism receipts from international tourists to employment and economic development. However, environmental conservation is necessary for protection as recommended by because Jatuporn and Chien (2011) who said policymakers in Thailand should provide environmental policies such as pollution taxes and environmental or responded cost credits in terms as a part of their social responsibility. Furthermore, Lee (2013) indicated that the number of international tourists has positive effects on electricity consumption in Singapore. Therefore, tourism should be considered as an environmental factor.

As mentioned above, tourism can provide an economic contribution to GDP but the environmental problem has to be recognized as well. Increasing CO2 pollution is, in part, caused by tourism expansion in Thailand (Jatuporn and Chien, 2011). However, the causal relationship between the tourism factor, which is tourism revenue, and CO2 emissions in Thailand have not been empirically tested. Tourism revenue is an alternative factor because it has been selected as a tourism factor in many studies such as Chancharat and Chancharat (2010) and Nonthapot (2013). Moreover, CO_2 emission from transportation is considered as a major pollution source, and higher levels of tourism lead to more use of transportation, which is in line with Jatuporn and Chien (2011) who analyzed the CO_2 emissions in transportation and energy consumption. Therefore, this research can fill the gap and generate a better understanding of the causal links between tourism and CO_2 emissions (which are divided into 3 factors) as well as to make some policy recommendations. In addition, the next section of the paper reviews the relevant literature; section 3 describes the data and methodology, section 4 presents the empirical results and section 5 concludes.

Literature Review

There have been many studies that have investigated the causal relationship between tourism and economic growth in Thailand. The studies of tourism development and economic growth estimation methods are based on investigating the casual relationship between tourism and growth. The studies always present the impact of tourism on long-run economic growth by using Engle and Granger (1987) causality tests based on error correction models as well as international tourism receipts and economic growth supporting both tourism and economic growth, for example, Chancharat and Chancharat (2010) and Nonthapot (2013).

According to the study of tourism development and CO_2 emissions, domestic energy consumption is basically defined as transportation and economic activities. The transport sector facilitates the travelling of tourists to the destination (Yeoman et al, 2007). In a recent study, Mayor and Tol (2010) investigated the tourism impact on pollution in future scenarios and employed the international flow of tourists as the key indicator. Their results showed that increased demand for transport is needed to develop tourism in the future, particularly in Asian countries. Fuel combustion in vehicles is considered as a major source of pollution emissions. In the case of the economic activities, many studies focused on tourism expansion, the growth of economic activities, and CO_2 emissions (Dritsakis, 2004; Durbarry, 2005; Chang, 2010; Zhang and Cheng, 2009). The growth of economic activities causes tourism expansion (Dritsakis, 2004 and Durbarry, 2005) but an increase of CO_2 emissions also results from economic growth (Chang, 2010; Zhang and Cheng, 2009). With transportation or economic activities used during leisure activities, CO_2 emissions originate from combustion processes and lead to global warming. Therefore, the growth of economic activities is a major factor in increasing energy usage (Soytas et al., 2007; Zhang and Cheng, 2009; Chang, 2010).

The relationship between CO_2 emissions and energy consumption has been proved in the long term in several countries. The more energy is used, the more CO_2 is emitted in the case of France (Ang, 2007). This result is consistent with Halicioglu (2009) who revealed that energy usage contributes to CO2 emissions in the long-run in Turkey. In addition, Apergis and Payne's (2009) also found support that the interrelationships between CO2 emissions, energy usage, and output in Central America are positive.

Recently, Lee (2013) indicated that tourism expansion is positively related to electricity consumption in Singapore. This finding suggests that electricity consumption in Thailand can be selected for the CO2 emission factor. This is because most of the electricity production in Thailand is generated from fossil fuels.

Tourism expansion is measured by employing the number of international tourist arrivals as the tourism factor. This expansion was found to have a relationship with CO2 in many studies. However, CO2 emissions from the transport sector, energy consumption and electricity consumption should be considered with the tourism expansion in Thailand. In particular, tourism revenue has not been analyzing together with CO2 before.

Data and Methodology

1. Data

The data of this research are derived from many sources. It comprises data from 1980 to 2013 which covers 34 observations of annual data. The details of the variables are as follows. Firstly, tourism revenue (TR) is employed as the quantity of revenue from tourism expansion in each year. These data are collected from the Tourism and Sports Ministry of Thailand. Secondly, CO2 emission from the transport sector (CT) is the total amount of CO2 emissions ('000s of tons) from the transport sector. The CO2 from the transport sector is provided by the Energy Policy and Planning Office of Thailand. Thirdly, CO2 emission from energy consumption (EP) is the volume of petroleum products in terms of million liters as representative of energy consumption and is provided by the Energy Policy and Planning Office of Thailand. Lastly, CO2 emission from electricity consumption (ET) is represented by the total of electricity consumption of KWH/mm. The data are collected from the Bank of Thailand. Additionally, all data are transformed to natural logarithms before the analysis. We will conduct the cointegration test by using the Zivot and Andrews (1992) and Granger causality test by Toda and Yamamoto (1995) respectively.

2. Methodology

2.1 Model

The models of tourism receipts and CO2 emissions are as follows:

$$\ln TR_i = \alpha_{1i} + \beta_1 \ln CT_{it} + \beta_2 \ln EP_{it} + \beta_3 \ln ET_{it} + \varepsilon_{1i} \quad (1)$$

$$\ln CT_i = \alpha_{2i} + \beta_4 \ln TR_{it} + \beta_5 \ln EP_{it} + \beta_6 \ln ET_{it} + \varepsilon_{1i} \quad (2)$$

$$\ln EP_i = \alpha_{3i} + \beta_7 \ln TR_{it} + \beta_8 \ln CT_{it} + \beta_9 \ln ET_{it} + \varepsilon_{3i} \quad (3)$$

$$\ln ET_i = \alpha_{4i} + \beta_{10} TR_{it} + \beta_{11} CT_{it} + \beta_{12} EP_{it} + \varepsilon_{4i} \quad (4)$$

From equations (1) to (4), the expected signs for coefficients of explanatory variables are β_1 to β_{12} are > 0

2.2 Unit Root Test for Stationary with Structure Break

In order to ascertain the order of integration, we perform Zivot and Andrews (1992) for one unknown structure break-point to confirm the order of integration for each series. This paper presents two versions of the Zivot and Andrews (1992) test for one structural break. The first one is model A, which allows for a structural break in the intercept and the second one is model C, which allows for a structural break in the intercept and slope (Tang and Lean, 2011). Model A and Model C are as follows:

Model A:

$$\Delta y_t = \kappa + \alpha y_{t-1} + \beta_t + \theta\, DU_t + \sum_{i=1}^{k} d_i \Delta y_{t-i} + \varepsilon_t \tag{5}$$

Model C:

$$\Delta y_t = \kappa + \alpha y_{t-1} + \beta_t + \theta DU_t + \gamma DT_t + \sum_{i=1}^{k} d_i \Delta y_{t-i} + \varepsilon_t \tag{6}$$

where Δ is the first difference operator, the residual ε_t is white noise and assumed to be a normal distribution. The incorporated Δy_{t-1} terms on the right-hand side of the equation (5) and (6) are to remove the serial correlation if any. The "*t*-significant" approach is employed to select the optimal lag length (*k*) (Hall, 1994). The breakpoint (*TB*)is chosen where the ADF *t*-statistics are maximized in absolute terms (Narayan, 2005). DU_t denotes an indicator dummy variable for a mean shift occurring at each possible break-date *(TB)* while DT_t denotes a corresponding trend shift variable. Formally,

$$DU_t = \begin{cases} 1.........if\ \ t > TB \\ 0.........otherwise \end{cases} \tag{7}$$

$$DT_t = \begin{cases} t - TB.........if\ \ t > TB \\ 0.........otherwise \end{cases} \tag{8}$$

This study proposes to find the long-run relationship among the four variables using the Granger causality test based on the alternative long-run Granger causality approaches. When the variables are integrated in the same order, the four variables will be tested with a suitable method such as Engle and Granger (1987); Johansen and Juselius (1990), and Saikkonen and Lütkepohl (2000) to estimate long-run equilibrium. In contrast, when the series are integrated in the I(0) it means the all variables have stationarity and can be directly tested by the bi-Granger causality test. Furthermore, if all variables do not have stationarity in the same order and do not have cointegration in the unrestricted vector autoregressive (VAR) based on the Granger causality test, the causality test with the maximal order of integration (*d*max) and the VAR optimal lag value are combined in the form of a VAR with lag order (*q*+*d*max) to reveal the long-run relationship (Toda and Yamamoto, 1995). The Toda and Yamamoto (1995) test does not require knowledge of the cointegration concept. Therefore, when there is no integration or stability, the order of integration is not the same order that is applied by the Toda and Yamamoto (1995) test. The models from equations 1 to 4 are presented in equations. (9) to (12):

$$\ln TR_t = \alpha_1 + \sum_{k=1}^{q}\beta_{1i}\ln TR_{t-k} + \sum_{k=q+1}^{q+d\max}\beta_2 \ln TR_{t-k} + \sum_{k=1}^{q}\lambda_{1i}\ln CT_{t-k} + \sum_{k=q+1}^{q+d\max}\lambda_2 \ln CT_{t-k} + \sum_{k=1}^{q}\kappa_{1i}\ln EP_{t-k} + \sum_{k=q+1}^{q+d\max}\kappa_2 \ln EP_{t-k} + \sum_{k=1}^{q}\eta_{1i}\ln ET_{t-k} + \sum_{k=q+1}^{q+d\max}\eta_2 \ln ET_{t-k} + \mu_{1t} \tag{9}$$

$$\ln CT_t = \alpha_2 + \sum_{k=1}^{q}\beta_{3i}\ln CT_{t-k} + \sum_{k=q+1}^{q+d\max}\beta_4 \ln CT_{t-k} + \sum_{k=1}^{q}\lambda_{3i}\ln TR_{t-k} + \sum_{k=q+1}^{q+d\max}\lambda_4 \ln TR_{t-k} + \sum_{k=1}^{q}\kappa_{3i}\ln EP_{t-k} + \sum_{k=q+1}^{q+d\max}\kappa_4 \ln EP_{t-k} + \sum_{k=1}^{q}\eta_{3i}\ln ET_{t-k} + \sum_{k=q+1}^{q+d\max}\eta_4 \ln ET_{t-k} + \mu_{1t} \quad (10)$$

$$\ln EP_t = \alpha_3 + \sum_{k=1}^{q}\beta_{5i}\ln EP_{t-k} + \sum_{k=q+1}^{q+d\max}\beta_6 \ln EP_{t-k} + \sum_{k=1}^{q}\lambda_{5i}\ln TR_{t-k} + \sum_{k=q+1}^{q+d\max}\lambda_6 \ln TR_{t-k} + \sum_{k=1}^{q}\kappa_{5i}\ln CT_{t-k} + \sum_{k=q+1}^{q+d\max}\kappa_6 \ln CT_{t-k} + \sum_{k=1}^{q}\eta_{5i}\ln ET_{t-k} + \sum_{k=q+1}^{q+d\max}\eta_6 \ln ET_{t-k} + \mu_{1t} \quad (11)$$

$$\ln ET_t = \alpha_4 + \sum_{k=1}^{q}\beta_{7i}\ln ET_{t-k} + \sum_{k=q+1}^{q+d\max}\beta_8 \ln ET_{t-k} + \sum_{k=1}^{q}\lambda_{7i}\ln TR_{t-k} + \sum_{k=q+1}^{q+d\max}\lambda_8 \ln TR_{t-k} + \sum_{k=1}^{q}\kappa_{5i}\ln CT_{t-k} + \sum_{k=q+1}^{q+d\max}\kappa_6 \ln CT_{t-k} + \sum_{k=1}^{q}\eta_{7i}\ln EP_{t-k} + \sum_{k=q+1}^{q+d\max}\eta_8 \ln EP_{t-k} + \mu_{1t} \quad (12)$$

Although equations (9) to (12) apply Toda and Yamamoto (1995), the testing employs the Granger causality test. This study follows the concept of Granger causality, '*X* causes *Y*' if and only if the past values of *X* help to predict the changes of *Y*. While '*Y* causes *X*' if and only if the past values of *Y* help to predict the changes of *X*. Granger (1988) stated that a variable set is not co-integrated, meaning that the considering model has short-run Granger causality.

Where $d\max$ is the maximal order of integration, q is optimal lag length, *p* is determined by the Akaike Information Criterion (AIC) with a maximum lag of four because it has a superior performance in a small sample (Lütkepohl, 2005, section 4.3.3). The residuals $\mu_{1t} \ldots \mu_{4t}$ are assumed to be normally distributed and white noise. Moreover, the chi-square statistics are then applied to find out the direction of Granger causality between the variables of interest. The null hypotheses that are tested which are follows:

(1). Equation (9) can be expressed as

1. $H_{01}: \lambda_{11} = \lambda_{12} = ..\lambda_{1q} = \lambda_{2(d\max)} = 0$, implying that $\ln CT$ does not Granger-cause $\ln TR$
2. $H_{02}: \kappa_{11} = \kappa_{12} ... = \kappa_{1q} = \kappa_{2(d\max)} = 0$, implying that $\ln CE$ does not Granger-cause $\ln TR$
3. $H_{03}: \eta_{11} = \eta_{12} ... = \eta_{1q} = \eta_{2(d\max)} = 0$, implying that $\ln EP$ does not Granger-cause $\ln TR$

(2). From equation (10) can be expressed to

4. $H_{04}: \lambda_{31} = \lambda_{32} ... = \lambda_{3q} = \lambda_{4(d\max)} = 0$, implying that $\ln TR$ does not Granger-cause $\ln CT$

(3). From equation (11) can be expressed to

5. $H_{05}: \lambda_{51} = \lambda_{52} ... = \lambda_{5q} = \lambda_{6(d\max)} = 0$, implying that $\ln TR$ does not Granger-cause $\ln EP$

(4). From equation (12) can be expressed to

6. $H_{06}: \lambda_{71} = \lambda_{72} ... = \lambda_{7q} = \lambda_{8(d\max)} = 0$, implying that $\ln TR$ does not Granger-cause $\ln ET$

Taking the stages 1 to 6, if both of the null hypotheses are rejected, it shows that there are causality nexus between tourism revenue and the CO2 emission factors. In contrast, there is no causal link between tourism revenue and CO2 emission factors if this test cannot reject both null hypotheses.

Empirical Results

According to the first step of analysis, each variable has to test the unit root., This study uses the unit root test with one structure break which follows Zivot and Andrews (1992)'s test. The results are shown in Table 1. All variables are tested both in model (A) with an intercept and model (C) with both an intercept and a trend. The CO2 from the transport sector ($\ln CT$) and tourism revenue ($(\ln TR)$) has no unit root when the variables are taken in model (C) at 1 and 5 percent levels of significance.

Table 1 The Zivot and Andrews (1992) Test Results

Variable		Model A	Model C	Variable		Model A	Model C
$\ln TR$	TB	**1988**	**1992**	$\ln EP$	TB	**1992**	**1994**
	α	-0.74 (-4.48)	-1.11 (-5.15)**		α	-0.39 (-3.24)	-0.47 (-3.60)
	θ	0.49 (3.97)	0.18 (1.76)		θ	0.27 (2.62)	0.20 (1.81)
	γ		-0.11 (-4.43)		γ		-0.04 (-3.41)
	κ	2	2		κ	2	1
$\ln CT$	TB	1987	1995	$\ln ET$	TB	1990	2000
	α	-0.20 (-3.09)	-0.99*** (-5.72)		α	-0.18 (-3.37)	-0.33 (-3.83)
	θ	0.11 (2.20)	0.15 (2.98)		θ	0.12 (5.35)	0.05 (1.84)
	γ	-	-0.09 (-5.35)		γ		0.01 (-2.74)
	κ	2	2		κ	2	2
Exact critical values		1% = -5.57 5% = -5.08	1% = -5.34 5% = -4.80	Exact critical values		1% = -5.57 5% = -5.08	1% = -5.34 5% = -4.80

*Note: t-statistics are in the parentheses. Asterisks *** and ** denote significance at 1% and 5% levels of significance respectively.*

In contrast, the energy consumption $(\ln EP)$ and electricity consumption $(\ln ET)$ factors are tested in model (C), which has a unit root. Furthermore, all variables are tested with model (A) and the unit root hypothesis cannot be rejected. Hence, the findings of the unit root test results with one structure break are that the series does not have stationarity as *I*(0) for all variables and a test for cointegration cannot be implemented such as Engle and Granger (1987); Johansen and Juselius (1990), and Saikkonen and

Lütkepohl (2000). Nevertheless, this study focuses on the causality test of Toda and Yamamoto (1995), which is not interested in the cointegration procedure and the order of all variables is different. Therefore, this study can confirm that the Toda and Yamamoto causality test is appropriate for analysis in the case of Thailand. Once the variables are integrated in a different order, the Granger causality approach through the processes stated by Toda and Yamamoto (1995) are performed in terms of the VAR with lag order $(q + d\max)$ model.

Table 2 presents the VAR lag model which is selected based on the lowest value at lag (4) by AIC with the lowest value at -10.24. Hence, the combination of VAR $(q + d\max)$ can be used as VAR (4+1). Based on the Toda and Yamamoto Granger causality test in Table 2, the modified Wald (χ^2) statistic is utilized to test the *k* parameters in the VAR(4+1) system with *k* degrees of freedom ($\chi^{2(k)}$).

Table 2 VAR optimal lag selection

Criteria	VAR lag selection				
	Lag (0)	Lag (1)	Lag (2)	Lag (3)	Lag (4)
AIC	-0.91	-9.58	-9.66	-10.00	-10.24

Note: Akaike Information Criterion (AIC) with a maximum lag of four, a superior performance in a small sample (Lütkepohl, 2005, section 4.3.3).

As the results show, from the Toda and Yamamoto Granger causality test shown in Table 3, there is a bi-directional relationship between tourism revenue and energy consumption. The results are unidirectional running from CO2 from transport sector to tourism revenue and unidirectional running from electricity consumption to tourism revenue at a 5 percent level of significance.

In contrast, the result is not show running from tourism revenue to CO2 from the transport sector and electricity consumption. Therefore, the result shows that tourism expansion leads to increased energy consumption and CO2 from transportation and electricity consumption is a result of increased tourism expansion. The summary of Toda and Yamamoto Causality Test results are shown in Table 4.

Conclusions

This paper examines the causal relationships between tourism expansion and CO2 emission factors in Thailand. The causality through Toda and Yamamoto (1995) is conducted with multivariate vector autoregressive (VAR) models following the tests by Zivot and Andrews (1992)'s unit root with one structure break procedures.

Firstly, based on the results of Toda and Yamamoto causality, the tourism revenue is the cause of increased electricity consumption in Thailand but also leads to increased tourism revenue. Therefore, tourism expansion is mutually related with CO2 emissions from energy consumption because tourism create events, exhibitions, and festivals that stimulate tourists visit to site attractions and therefore use transportation-related and other energy resources. This finding is consistent with Jatuporn and Chien (2011) in that it is possible that tourism leads to increase the volume of petroleum production and energy use in Thailand. Furthermore, this finding is consistent with Mayor and Tol (2010) who found the leisure industry has played a role in domestic CO2 emissions. It can be inferred that production and services that consume energy would increase as a result of travel and tourism. Hence, this finding shows that CO2 emissions are bi-directionally related to tourism in Thailand.

Table 3 Results of the Toda and Yamamoto Causality Test

Dependent Variables	Lag	Type of causality			
		Source of Causation (χ^2 – stats)			
		$\ln TR_t$	$\ln CT_t$	$\ln EP_t$	$\ln ET_t$
$\ln TR_t$	5	-	11.35**	12.23**	11.58**
$\ln CT_t$	5	8.92	-	17.04***	13.58**
$\ln EP_t$	5	28.52***	9.23	-	32.97***
$\ln ET_t$	5	6.20	7.09	1.36	-

*Note: Asterisks *** and ** denote significance at the 1% and 5% levels respectively.*

Table 4 Summary of Toda and Yamamoto Causality Test Results

Toda and Yamamoto Causality Relationships			Significance Level
Tourism Revenue	←	CO2 from transport sector	5%
Tourism Revenue	↔	Energy consumption	1% and 5%
Tourism Revenue	←	Electricity consumption	5%

Note: → means variable x does Granger cause variable y.

← means variable y does Granger cause variable x.

↔ means variable x does Granger cause variable y and variable y does Granger cause variable x.

Secondly, the CO2 emissions from transportation and electricity consumption are a result of tourism expansion because CO2 emissions from those two sources are pollution at least in part caused by the tourism sector. Based on the findings, Yeoman et al., (2007) explained that the transport sector is a key factor of tourism development that facilitates the movement of tourists from their sources to the destination. Therefore, this study finds CO2 emissions are basically a result of transportation consumption through domestic energy because if the volume of transport expenditure increases, it can lead to increase the number of tourists and tourism revenue. Finally, the transport sector can support tourism expansion.

Thirdly, the study of CO2 emissions from electricity consumption shows that electricity consumption is a result of tourism expansion because the growing volume of electricity consumption may be connected to investment in infrastructure which is related to the tourism sector such as communication and electric lighting. Therefore, the increase of electricity consumption is caused by an increased number of tourism activities, which is linked to tourism revenue and tourism expansion.

Finally, tourism increases energy consumption but the CO_2 emissions are caused by the transport sector. Increased energy and particularly electricity consumption are caused by tourism expansion. The increasing number of tourist arrivals in Thailand leads to increased transportation expenditure, energy consumption and electricity consumption. These factors lead to tourism and are linked to tourism revenue from tourism expenditure. The research also found that CO_2 emissions from energy consumption are environmental problems that affect tourism expansion in Thailand. This research suggests that policymakers should suitably provide petroleum energy policy such as petroleum taxes and compensation to reduce the pollution in the country. In addition, Thailand's government and tourism entrepreneurs should create green tourism campaigns for domestic and international tourists to reduce CO_2 emissions from energy consumption and to change tourist behaviors.

References

Ang, J. B. (2007). CO2 emissions, energy consumption, and output in France. *Energy Policy*. 35(10): 4772-4778.

Apergis, N. and Payne, J. E. (2009). CO2 emissions, energy usage, and output in Central America. *Energy Policy.* 37(8): 3282-3286.

BBC News. (2014). *Thailand crisis: Protesters launch Bangkok 'shutdown'.* [cited 2013 Feb 12]; Available from http://www.bbc.com/news/world-asia-25708092.

Beladi, H., Chao, C. C., Hazari, B. R. and Laffargue, J. P. (2009). Tourism and the environment, *Resource and Energy Economics.* 31(1): 39-49.

Chancharat, S. and Chancharat, N. (2010). Tourism development and economic growth: Evidence from Thailand. *International Journal of Applied Business and Economic Research.* 8(1): 65-77.

Chang, C. C. (2010). A multivariate causality test of carbon dioxide emissions, energy consumption and economic growth in China. *Applied Energy*. 87(1): 3533-3537.

Dritsakis, N. (2004). Tourism as a long-run economic growth factor: An empirical investigation for Greece using causality analysis. *Tourism Economics*.10(3): 305-316.

Durbarry, R. (2004). Tourism and economic growth: The case of Mauritius. *Tourism Economics.* 10(4): 389-401.

Engle, R. F. and Granger, C. W. J. (1987). Cointegration and error correction: Representation, estimation and testing. *Econometrica.* 55(2): 251-276.

Halicioglu, F. (2009). An econometric study of CO2 emissions, energy consumption, income and foreign trade in Turkey. *Energy Policy*. 37(3): 1156-1164.

Hall, A. D. (1994) Testing for a unit root in time series with pretest data based model selection, *Journal of Business and Economic Statistics.* 12(4): 461–70.

Jatuporn, C. and Chien, L-H. (2011). "Tourism Development Vs CO2 Emissions in Thailand", proceeding of the 1st Environment Asia International Conference on "Environmental Supporting in Food and Energy Security: Crisis and Opportunity"; *22-25* March 2011, Bangkok, Thailand. Thai Society of Higher Education Institutes on Environment. 247-256.

Johansen, S. and Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration with application to the demand for money. *Oxford Bulletin of Economics and Statistics.* 52(2): 169-209.

Lee, C. G. (2013). Electricity consumption and international tourism: the case of Singapore. *Anatolia: An International Journal of Tourism and Hospitality Research.* 24(1): 91-94.

Lütkepohl, H. (2005). New Introduction to Multiple Time Series Analysis, Berlin: Springer-Verlag.

Mekong Tourism Coordinating Office, 2008. *Mekong Tourism Office Marketing plan2008–2011*. [cited 2013 Feb 10] ; Available from http://www.mekongtourism.org/docs/Mekong_Tourism_Marketing_Plan_%28Jan08%29.pdf

Mayor, K. and Tol, R. S. J. (2010). Scenarios of carbon dioxide emissions from aviation. *Global Environmental Change.* 20(1): 65-73.

Mirbabayev, B. and Shagazatova, M. (2006). The Economic and Social Impact of Tourism National Graduate Institute for Policy Studies. [cited 2013 Mar 12] ; Available from http://www.grips.ac.jp

Nayaran, P. K. (2005). he saving and investment nexus for china: evidence from cointegration tests. *Applied Economics*. 37: 1979-1990.

Nonthapot, S. (2013). Tourism and economic growth of Thailand testing: new evidence from ARDL and rolling window Approaches. *International Journal of Applied business and economic research.* 11(2):251-260.

Nonthapot, S. and Lean, H. H. (2013). Demand of Thai Tourists to Lao PDR: An ARDL Approach. *Asian Journal of Empirical Research*. 3(3): 279-285.

Saikkonen, P. and Lütkepohl, H. (2000).Testing for the cointegrating rank of a VAR process with an intercept. *Econometric Theory*. 16: 373-406.

Soytas, U., Sari, R. and Ewing, B. T. (2007). Energy consumption, income, and carbon emissions in the United States. *Ecological Economics*. 62(3-4): 482-489.

Tang, C. F. and Lean, H. H. (2011). Revisit Feldstein-Horioka puzzle: evidence from Malaysia. *Economics Bulletin*. 31(3): 2237-2249.

Toda, H. Y. and Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated process. *Journal of Econometrics.* 66(1-2): 225-250.

World Travel and Tourism Council.(2014). *Economic Impact Research.* [cited 2013 Feb 12] ; Available from http://www.wttc.org/research/economic-data-search-tool

Yeoman, I., Lennon, J. J., Blake, A., Galt, M., Greenwood, C. and Beattie, U. M. (2007). Oil depletion: What does this mean for Scottish tourism? *Tourism Management*. 28(5). 1354-1365.

Yildirim, E., Sukruglu, D. and Aslan, A. (2014). Energy consumption and economic growth in the next 11 countries: The bootstrapped autoregressive metric causality approach. *Energy Economics*. 44:14-21.

Zivot, E. and Andrews, D. W. K. (1992) Further evidence of the great crush, the oil price shock and the unit root hypothesis. *Journal of Business and Economic Statistics*. 10(3): 251–70.

Zhang, X. P. and Cheng, X. M. (2009). Energy consumption, carbon emission, and economic growth in China. *Ecological Economics*. 68(10): 2706-2712.